sPHENIX CD-1 Documentation - Status

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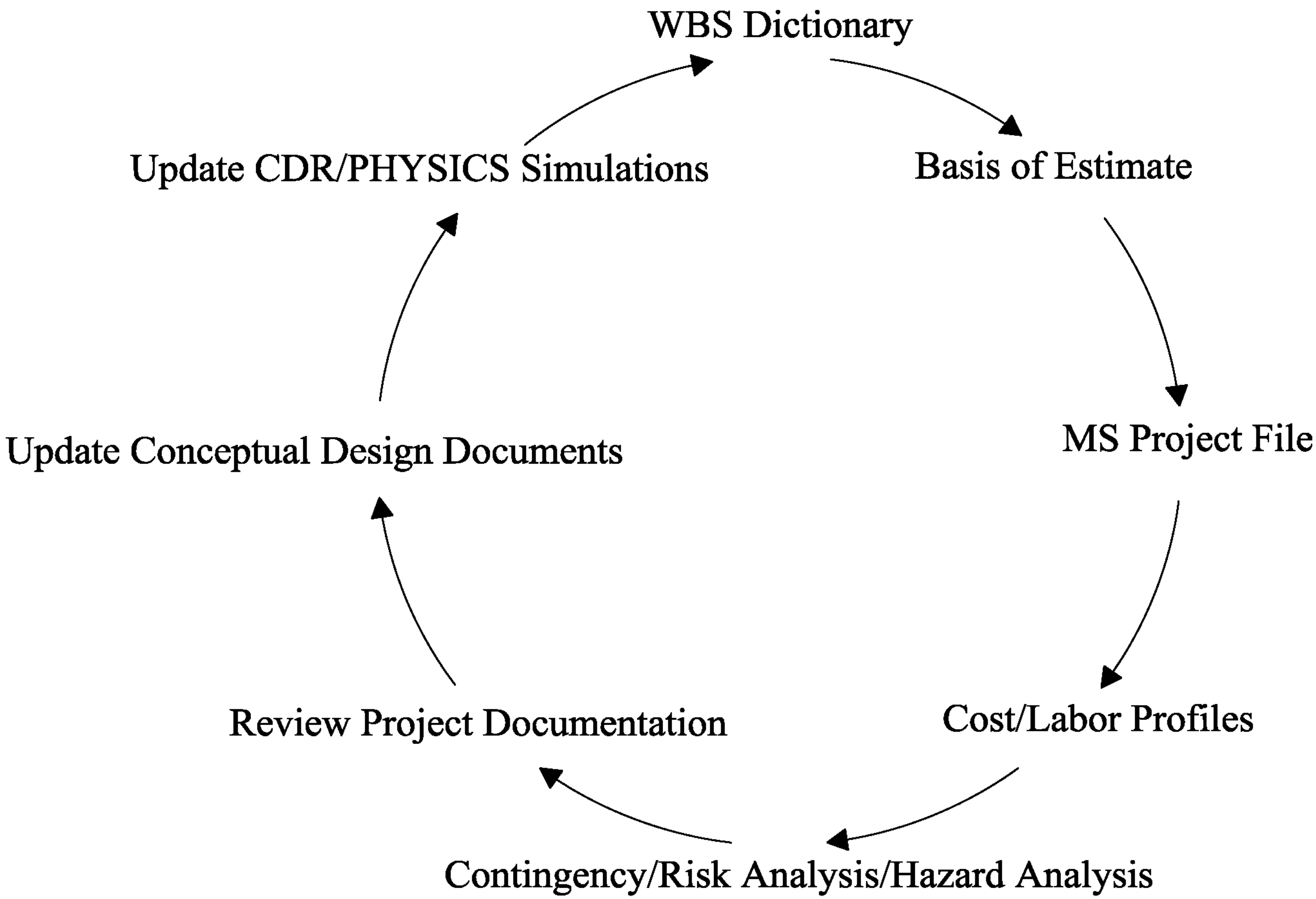
June 5, 2017

sPHENIX CD-1 Document Preparation

Continuous Flow and Updating of Information



CD-1 Review Document Status

1. Integrated Project Team- Complete
2. WBS (WBS Dictionary)- Updated
3. Basis of Estimate
4. Contingency Risk/Analysis
5. Activity List & Activity Attributes
6. Project Schedule
7. Critical Milestones
8. Proposed Funding Profile
9. Proposed Labor Profile
10. Preliminary Hazard Analysis Report- Draft
11. NEPA Document- Complete
12. Integrated Safety Management Plan- In Development
13. Conceptual Design/Conceptual Design Report- Advanced Design/ Advanced Draft
14. Acquisition Strategy- In Development
15. Close all previous review recommendations- Ongoing
16. Preliminary Project Execution Plan- Draft
17. Preliminary Risk Management Plan- Initial Release for Use
18. Preliminary Risk Assessment and Risk Registry- Advanced Draft
19. Preliminary Security Vulnerability Assessment (Short security equipment protection & cyber security)- Complete
20. Alternate Analysis- For the PEP includes scientific alternatives- In Development

sPHENIX L2, CAMs, Project Office, and Engineers have been working on this for the past 6 months. All derived from WBS MS-Project file- Updated

Integrated Safety, ESH

Risk Management

Additional Project Controls and Work Management Documents

1. **sPHENIX Procedure Guidelines- Pending Release**
2. **sPHENIX Configuration Management- Pending Release**
3. **sPHENIX Document Control- Pending Release**
4. **sPHENIX Quality Assurance Plan- Pending Release**
5. **sPHENIX Work Planning- Pending Release**
6. **sPHENIX Awareness Training- Pending Release**
7. **sPHENIX Bottom's-Up Contingency Guidelines- Released and Distributed**

Access to CD-1 Documentation

PHENIX

sPHENIX CD-1

Search this site

CD-1 DOCUMENTS

ADDITIONAL DOCUMENTS

BASIS OF ESTIMATE DOCUMENTATION

SITEMAP

CD-1 Documents

- Conceptual Design Report
- Risk registry
- Preliminary Hazard Analysis
- WBS Dictionary
- NEPA documents
  - NEPA Approval memo
  - sPHENIX NEPA form

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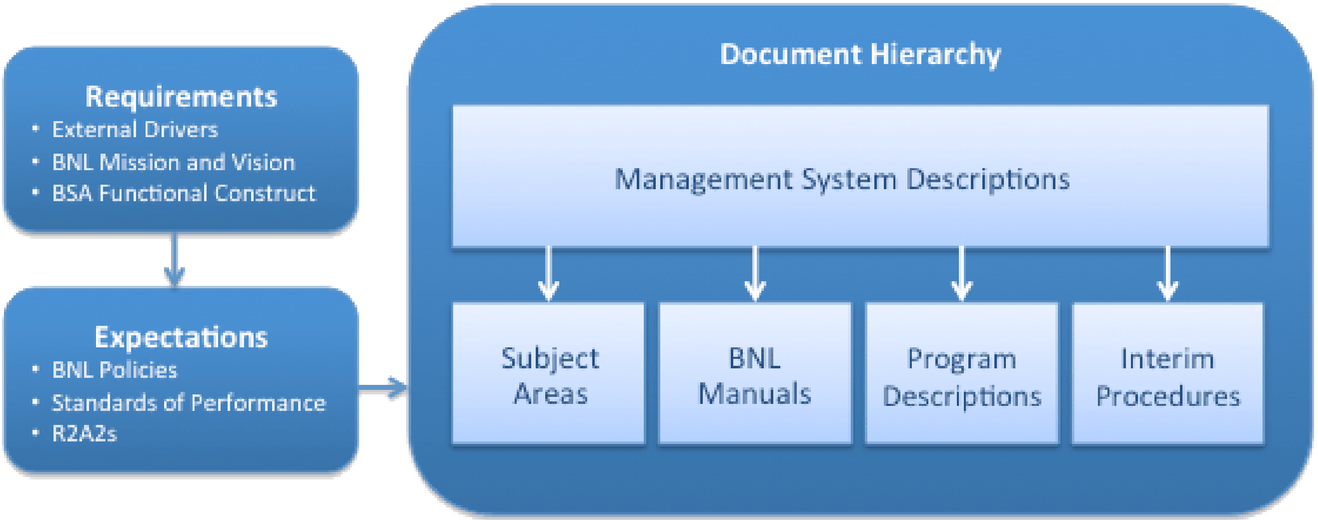
Standards Based Management (SBMS)

Brookhaven National Laboratory SBMS

The Standards-Based Management System (SBMS) provides Laboratory-wide procedures and guidelines for performing work safely and in compliance with requirements. All work at the Laboratory must comply with the minimum requirements specified in SBMS documents, including management system descriptions, subject areas, interim procedures, BNL manuals, and program descriptions.



Management System: Project Management

Introduction

This subject area provides Laboratory-wide requirements and procedures for managing work at Brookhaven National Laboratory (BNL) that is subject to DOE's Project Management system. Compliance with requirements of Appendix A of DOE Order 413.3B is required for all capital asset acquisitions with a total project cost (TPC) that is greater than or equal to $50 million.

Engineering Design (SBMS)

Subject Area: Engineering Design

Introduction

This subject area describes how to create, modify, distribute, and review engineering calculations, drawings and specifications, and establish configuration control (see the Configuration Management Program Description, or contact the Configuration Management Subject Matter Expert) for both equipment used for scientific purposes and facility construction. It provides for the verification and validation of design adequacy by Technical Authorities (i.e., competent individuals, approved by management, other than those who performed the work), before the approval and implementation of the design. It uses a process that fosters the use of sound engineering/scientific principles, risk management, and standards for design work.

Work Planning (SBMS)

Subject Area:
<u>Work Planning and Control for Experiments and Operations</u>

Introduction

This subject area uses the Integrated Safety Management core functions and guiding principles to establish a process for ensuring all work, operational and experimental, is properly planned and implemented to prevent accidents, injuries, and regulatory violations. It establishes requirements at Brookhaven National Laboratory (BNL) so that all work is properly managed by using a level of planning and control commensurate to the Environment, Safety, Security, and Health (ESSH) hazards, job complexities, and work coordination needs. Line management is directly responsible for the protection of the public, the workers, and the environment.

Project Execution Plan

- **Preliminary Key Performance Parameters**
- **Organization Chart**
- **Roles and Responsibilities**
- **Preliminary Schedule**
- **Preliminary WBS**
- **Preliminary Cost Baseline and Funding Profile**
- **Environmental, Safety, and Health**
- **Project Management Oversight and Controls**

Contents

control process by which the project scope, schedule and budget can be revised. The PEP will be reviewed, revised and updated as appropriate throughout the execution of the sPHENIX project.

1.2 Mission Need

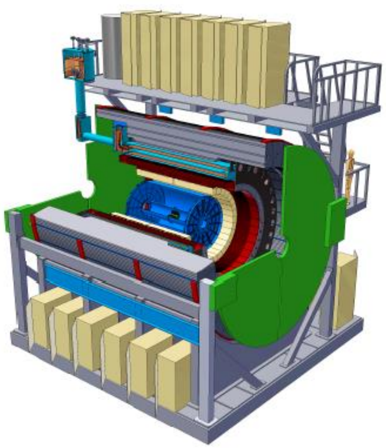
The mission of the Office of Science (SC) is to deliver the scientific discoveries and major scientific tools that transform our understanding of nature and advance the energy, economic and national security of the United States. SC accomplishes this mission through the direct support of research, construction and operation of national scientific user facilities, and the stewardship of nine world-class national laboratories and one pretty good national laboratory. The SC national laboratories collectively comprise a preeminent federal research system that develops unique, often multidisciplinary, scientific capabilities beyond the scope of academic and industrial institutions, to benefit the nation's researchers and national strategic priorities.

Conceptual Design Report

sPHENIX Conceptual Design Report

DRAFT VERSION 1.51 FOR COLLABORATION REVIEW

June 1, 2017



Bookmarks

Executive Summary

sPHENIX[1] is a proposal for a major upgrade to the PHENIX experiment at RHIC capable of measuring jets, jet correlations and upsilons to determine the temperature dependence of transport coefficients of the quark-gluon plasma. The detector needed to make these measurements require electromagnetic and hadronic calorimetry for measurements of jets, a high resolution and low mass tracking system for reconstruction of the Upsilon states, and a high speed data acquisition system.

This document describes a design for a detector capable of carrying out this program of measurements built around the BaBar solenoid. As much as possible, the mechanical, electrical, and electronic infrastructure developed for the PHENIX experiment from 1992-2016 is reused for sPHENIX. The major new systems are the superconducting magnet, a high precision tracking system, and electromagnetic and hadronic calorimeters.

Several alternatives for tracking technologies have been explored, and the conceptual design has converged on studying the physics capability of a reference design consisting of a small Time Projection Chamber with a silicon strip detector and a Monolithic Active Pixel (MAPS) detector within the inner radius. The feasibility of the detector and electronics has been evaluated through simulation, design, and prototyping.

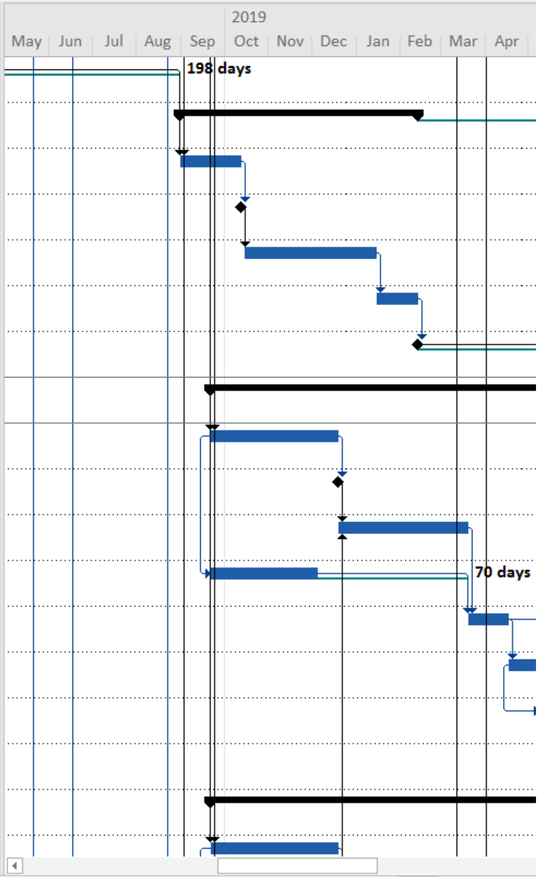
The electromagnetic calorimeter is a compact tungsten-scintillating fiber design located inside the solenoid. There are two sections of hadronic calorimeter, one inside the solenoid and the other outside made of steel-scintillator in a somewhat novel arrangement in which scintillator tiles with light collected by wavelength shifting fiber are sandwiched between tapered absorber plates that project nearly radially from the interaction point. The calorimeters use a common set of silicon photomultiplier photodetectors and amplifier and digitizer electronics.

The detector design has been evaluated by means of GEANT4 simulation and measurements with prototypes of some of the detectors. Additional simulation and testing of components is being pursued to finalize the design.

sPHENIX MS Project Plan

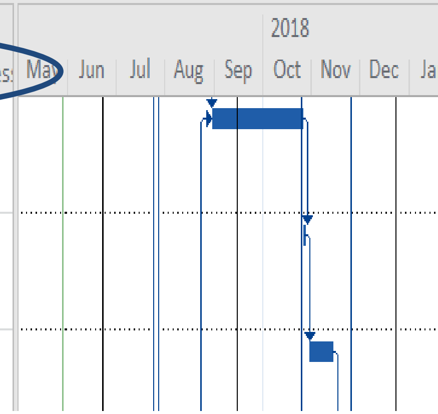
1850+ Tasks and Summary Tasks – Built from Bottom - Up
Fully Developed by L2 Managers and CAMs
Integrated by L2 Managers, CAMs and Project Office

WBS	Name	Duration	Start	Finish	Resource Names	Cost	Fixed_Cost_	Predecessors	Successors
1.4.2.2.8	Inner HCAL End Rings Design Complete	0 days	Mon 11/13/17	Mon 11/13/17		$0.00	$0.00	40	43
1.4.2.2.9	**Procure Inner HCAL End Rings**	**110 days**	**Fri 8/31/18**	**Tue 2/12/19**		**$76,205.20**	**$50,000.00**		
1.4.2.2.9.1	Procurement for Inner HCAL End Rings	30 days	Fri 8/31/18	Fri 10/12/18	SCI3 PO[5%],PROF4	$5,907.60	$0.00	10,41	44
1.4.2.2.9.2	Award Procurement for Inner HCAL End Rings	0 days	Fri 10/12/18	Fri 10/12/18		$0.00	$0.00	43	45
1.4.2.2.9.3	Manufacture Inner HCAL End Rings	60 days	Mon 10/15/18	Mon 1/14/19	PROF4 PO M[10%],TECH3	$58,899.20	$50,000.00	44	46
1.4.2.2.9.4	Inspect Inner HCAL End Rings	20 days	Tue 1/15/19	Tue 2/12/19	TECH3 PO M[50%],PROF4	$11,398.40	$0.00	45	47
1.4.2.2.9.5	Complete Procurement of Inner HCAL End Rings	0 days	Tue 2/12/19	Tue 2/12/19		$0.00	$0.00	46	12
1.4.2.2.10	**Procure Inner HCAL Sector Mechanical Structure (Vendor**	**380 days**	**Fri 9/21/18**	**Thu 4/2/20**		**$835,648.96**	**$759,244.00**		
1.4.2.2.10.1	Procurement for Inner HCAL Sector Mechanical Structure	60 days	Fri 9/21/18	Tue 12/18/18	SCI3 PO[5%],PROF3	$67,125.12	$56,004.00	10,32,37	50,52SS
1.4.2.2.10.2	Award Procurement for Inner HCAL Sector Mechanical	0 days	Tue 12/18/18	Tue 12/18/18		$0.00	$0.00	49	51
1.4.2.2.10.3	Inner HCAL Sector Mechanical Structure First	60 days	Wed 12/19/18	Tue 3/19/19	PROF4 PO M[10%],TECH3	$52,539.20	$43,640.00	50,59	53
1.4.2.2.10.4	Design and procure Inner HCAL Sector acceptance	50 days	Fri 9/21/18	Tue 12/4/18	PROF3 PO M[10%],TECH3	$13,437.60	$5,000.00	49SS	53
1.4.2.2.10.5	Inner HCAL Sector Mechanical Structure First	20 days	Wed 3/20/19	Tue 4/16/19	TECH3_Institut PO	$5,935.04	$0.00	51,52	54,87
1.4.2.2.10.6	Inner HCAL Sector Mechanical Structure	225 days	Wed 4/17/19	Thu 3/12/20	TECH3_Institut PO	$674,886.00	$654,600.00	53	55SS+15 days
1.4.2.2.10.7	Inner HCAL Sector Mechanical Structure	225 days	Wed 5/8/19	Thu 4/2/20	TECH3_Institut PO	$21,726.00	$0.00	54SS+15 days	56
1.4.2.2.10.8	Complete Procure Inner HCAL Sector Mechanical Structure	0 days	Thu 4/2/20	Thu 4/2/20		$0.00	$0.00	55	12
1.4.2.2.11	**Procure Inner HCAL Sector Mechanical Structure (Vendor**	**380 days**	**Fri 9/21/18**	**Thu 4/2/20**		**$829,698.16**	**$759,244.00**		
1.4.2.2.11.1	Procurement for Inner HCAL	60 days	Fri 9/21/18	Tue 12/18/18	SCI3	$67,125.12	$56,004.00	10,32,37	59,61SS



sPHENIX MS Project Plan

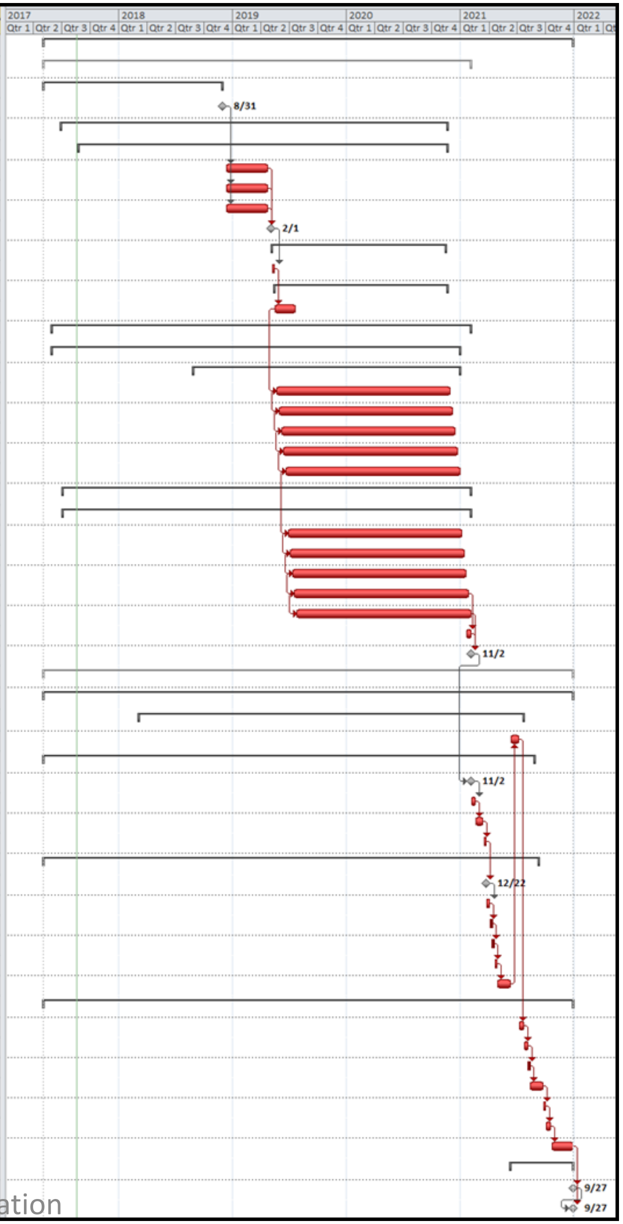
	WBS	Name	Duration	Start	Finish	Resource Names	Cost	Fixed_Cost	Predecessors	Succes:
38	1.4.2.2.5	Design Inner HCAL End Rings	40 days	Wed 8/30/17	Wed 10/25/17	TECH3 PO D[25%],PROF4 PO M[10%]	$9,825.60	$0.00	36,77FS-5 days	39
39	1.4.2.2.6	Internal Review of Inner HCAL End Rings	2 days	Thu 10/26/17	Fri 10/27/17	PROF4 PO M,SCI3 PO,TECH3 PO	$4,910.40	$0.00	38	40
40	1.4.2.2.7	Address Issues from Internal Review of Inner HCAL End Rings	10 days	Mon 10/30/17	Mon 11/13/17	TECH3 PO D[25%],PROF4	$3,428.40	$0.00	39	41



WBS	Name	Duration	Start	Finish	Resource Names	Cost	Fixed_Cost	Predecessors
1.4.2.2.5	Design Inner HCAL End Rings	40 days	Wed 8/30/17	Wed 10/25/17	TECH3 PO D[25%],PROF4 PO M[10%]	$9,825.60	$0.00	36,77FS-5 days

Critical Path Through EMCal Block and Module Production

WBS	Task Name	Duration	Start	Finish
1	sPHENIX_Project	1161 days?	2/1/17	9/27/21
1.3	sPHENIX_EMCal	938 days	2/1/17	11/2/20
1.3.1	EMCAL Management	396 days	2/1/17	8/31/18
1.3.1.5	CD-2b/CD-3b Authorization	0 days	8/31/18	8/31/18
1.3.2	EMCAL Block Production	847 days	3/31/17	8/21/20
1.3.2.3	EMCAL Final Block Production	808 days	5/25/17	8/21/20
1.3.2.3.7	Order & deliver epoxy for final blocks	90 days	9/10/18	1/22/19
1.3.2.3.8	Order parts and fabricate mold parts for final blocks	90 days	9/10/18	1/22/19
1.3.2.3.9	Set up factory for final blocks	90 days	9/10/18	1/22/19
1.3.2.3.12	Readiness and Safety Review for final block production	8 days	1/23/19	2/1/19
1.3.2.3.13	Fabricate final blocks	384 days	2/4/19	8/14/20
1.3.2.3.13.1	Fabricate final blocks sector 1	6 days	2/4/19	2/11/19
1.3.2.3.14	Pack and ship final blocks to BNL	383 days	2/12/19	8/21/20
1.3.2.3.14.1	Pack and ship final blocks for sectors 1-8 to BNL	48 days	2/12/19	4/19/19
1.3.3	EMCAL Module Production and Sector Assembly	919 days	3/1/17	11/2/20
1.3.3.2	EMCAL Module Production	894 days	3/1/17	9/28/20
1.3.3.2.3	EMCAL Final Module Production	583 days	5/29/18	9/28/20
1.3.3.2.3.6	Receive, unpack, log & inspect final blocks	384 days	2/19/19	8/28/20
1.3.3.2.3.7	Install light guides on final blocks	384 days	2/26/19	9/4/20
1.3.3.2.3.8	Install reflectors and mounting supports on final blocks	384 days	3/5/19	9/14/20
1.3.3.2.3.9	Install SiPMs & daughterboards on final blocks	384 days	3/12/19	9/21/20
1.3.3.2.3.10	Glue final blocks together into modules	384 days	3/19/19	9/28/20
1.3.3.3	EMCAL Sector Assembly	896 days	4/3/17	11/2/20
1.3.3.3.3	EMCAL Final Sector Assembly	896 days	4/3/17	11/2/20
1.3.3.3.3.11	Install modules in final sectors	384 days	3/26/19	10/5/20
1.3.3.3.3.12	Install readout electronics on final sectors	384 days	4/2/19	10/12/20
1.3.3.3.3.13	Install cables & cooling system on final sectors	384 days	4/9/19	10/19/20
1.3.3.3.3.14	Test final sectors with LEDs & cosmic rays	384 days	4/16/19	10/26/20
1.3.3.3.3.15	Repair or rework any sectors as required	384 days	4/23/19	11/2/20
1.3.3.3.3.16	Installation Readiness Review	10 days	10/20/20	11/2/20
1.3.4	Install sectors into sPHENIX	0 days	11/2/20	11/2/20
1.10	sPHENIX_Integration_and_Installation	1161 days	2/1/17	9/27/21
1.10.2	Integration Management & Technical Coordination, Installation Tooling & Fixtures & Subsystem Installation	1161 days	2/1/17	9/27/21
1.10.2.2	Infrastructure Installation	841 days	12/4/17	4/20/21
1.10.2.2.3	Install Beampipe/Vacuum/Bakeout	20 days	3/10/21	4/6/21
1.10.2.7	EMCal Installation	1076 days	2/1/17	5/25/21
1.10.2.7.7	EMCal Sectors Ready for Installation	0 days	11/2/20	11/2/20
1.10.2.7.8	Transport Assembled EMCal Sectors to AH	10 days	11/3/20	11/17/20
1.10.2.7.9	Install EMCal Sectors	16 days	11/18/20	12/11/20
1.10.2.7.10	Align/Survey EMCal to SC Magnet Centerline	7 days	12/14/20	12/22/20
1.10.2.8	TPC Installation	1086 days	2/1/17	6/9/21
1.10.2.8.7	TPC Ready for Installation	0 days	12/22/20	12/22/20
1.10.2.8.8	Transport Assembled TPC Sections to AH	5 days	12/23/20	12/31/20
1.10.2.8.9	Install TPC Support	5 days	1/4/21	1/8/21
1.10.2.8.10	Install TPC (Mechanical)	5 days	1/11/21	1/15/21
1.10.2.8.11	Align/Survey TPC to SC Magnet Centerline	5 days	1/19/21	1/25/21
1.10.2.8.12	Install TPC Cables and Services	30 days	1/26/21	3/9/21
1.10.2.11	Min Bias Installation	1161 days	2/1/17	9/27/21
1.10.2.11.9	Install Min Bias Support	10 days	4/7/21	4/20/21
1.10.2.11.10	Install Min Bias (mechanical)	10 days	4/21/21	5/4/21
1.10.2.11.11	Align/Survey Min Bias to SC Magnet Centerline	5 days	5/5/21	5/11/21
1.10.2.11.12	Install Min Bias Cables and Services	30 days	5/12/21	6/23/21
1.10.2.11.13	Review Min Bias for Operational Readiness (ORR)	5 days	6/24/21	6/30/21
1.10.2.11.14	Address Action Items from Min Bias ORR	10 days	7/1/21	7/16/21
1.10.2.11.15	Commission Min Bias	50 days	7/19/21	9/27/21
1.10.2.12	sPHENIX Full Detector Installation	140 days	3/10/21	9/27/21
1.10.2.12.9	All Design/Safety/Readiness Reviews Complete, sPHENIX Ready for Operations	0 days	9/27/21	9/27/21
1.10.9	sPHENIX Ready for Run 1	0 days	9/27/21	9/27/21



WBS Dictionary – Defined to Work Package Level

WBS	WBS	WBS L4	WBS L5	WBS Name	Dictionary Definition
1.1					
1.1				**SPHENIX PROJECT MANAGEMENT**	PROJECT MANAGEMENT FOR ALL SPHENIX WBS ITEMS FROM 1.2 TO 1.10 AND INCLUDING ALL PROJECT STAGES FROM CONCEPTUAL DESIGN TO CD-4 APPROVAL.
1.1	1.1.1			**Project Management of sPHENIX**	COST CONTENT: LABOR COST COVERING THE PROJECT MANAGEMENT TEAM. MATERIAL COSTS FOR TRAVEL OF THE MANAGEMENT TEAM OVER THE LIFE OF THE PROJECT. ADDITIONAL MATERIAL COSTS ASSOCIATED WITH PREPARATION FOR DOE AND BNL REVIEWS. THIS TASK INCLUDES ALL SCIENTIFIC, ENGINEERING, TECHNICAL AND SUPPORT STAFF EFFORTS TO PLAN AND SUPERVISE ALL ASPECTS OF THE ASSEMBLY, INTEGRATION AND INSTALLATION OF THE SPHENIX DEFINED IN WBS 1.2 THROUGH WBS 1.10. WORK STATEMENT: TASKS TO BE PERFORMED BY THE PROJECT MANAGEMENT TEAM INCLUDE: 1) THE OVERSIGHT AND MANAGEMENT OF THE DESIGN, CONSTRUCTION, INSTALLATION AND COMMISSIONING OF SPHENIX . 2) PREPARATION FOR DOE AND BNL REVIEWS INCLUDING CD REVIEWS BY OPA, DOE ANNUAL REVIEW, SAFETY REVIEWS, READINESS REVIEWS, ETC. 3)PREPARATION AND SUBMISSION OF ALL REPORTS AND DOCUMENTATION REQUIRED BY DOE AND BNL INCLUDING CONCEPTUAL AND TECHNICAL DESIGN REPORTS, EARNED VALUE REPORTS, ES&H PLANS, PROCUREMENT PLANS, ETC. 4) MONITORING THE ACTIVITIES OF ALL WBS TASKS THROUGH THE LEVEL2 MANAGERS TO ASSURE ASSURE ADHERENCE TO THE TECHNICAL, BUDGET AND SCHEDULE PLAN OF THE SPHENIX PROJECT. 5)WORK WITH THE LEVEL2 MANAGERS TO MONITOR ALL VENDOR ACTIVITY TO ASSURE COMPLIANCE WITH TECHNICAL, BUDGET AND SCHEDULE SPECS.
1.1	1.1.2			**Travel for sPHENIX Project Management**	TRAVEL TO FACILITATE ACTIVITIES INCLUDED IN WBS 1.1.1
1.2					
1.2				**SPHENIX TPC**	The Time Projection Chamber for the sPHENIX Experiment at RHIC
1.2	1.2.1			**TPC Mechanics**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE TPC PROTOTYPE VERSION 1/2, PERFORM R&D, DESIGN AND CONSTRUCT THE ELEMENTS OF THESE PROTOTYPES AND THE FINAL TPC INCLUDING THE HV SYSTEM. WORK STATEMENT: PROVIDE PROTOTYPES: V1/2 FIELD CAGE PROTOTYPE; V1/2 MODULE PROTOTYPING, INCLUDING GAS ENCLOSURE, COMMON MODULE MECHANICS, MODULE PROTOTYPE, V2 FIELD CAGE MODIFICATIONS, SITE PREP FOR PRODUCTION FACTORIES.
1.2	1.2.1	1.2.1.1		**TPC v1 Field Cage Prototype**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE TPC FIELD CAGE PROTOTYPE VERSION 1, PERFORM R&D, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE.WORK STATEMENT: PROVIDE PROTOTYPE: FIELD CAGE V1 PROTOTYPE.
1.2	1.2.1	1.2.1.2		**TPC v2 Field Cage**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE TPC FIELD CAGE PROTOTYPE VERSION 2, PERFORM R&D, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE. WORK STATEMENT: PROVIDE PROTOTYPE: FIELD CAGE V2 PROTOTYPE.
1.2	1.2.1	1.2.1.3		**TPC Final Field Cage**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE TPC FINAL FIELD CAGE. PERFORM NECESSARY MODIFICATION TO THE V2 FIELD CAGE. WORK STATEMENT: PROVIDE PROTOTYPES: MODIFY V2 FIELD CAGE PROTOTYPE AND TESTING, INCLUDING PROCURING PARTS THAT HAVE BEEN DEVELOPED DURING PROTOTYPING.
1.2	1.2.1	1.2.1.4		**TPC v1 Modules**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE GEM READOUT MODULE PROTOTYPE VERSION 1, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE. WORK STATEMENT: PROVIDE GEM READOUT MODULE V1 PROTOTYPE AND MATERIAL/EQUIPMENT TO PRODUCE THE MODULES.
1.2	1.2.1	1.2.1.4	1.2.1.4.1	**TPC v1 Module Gas Enclosure**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE GAS ENCLOSURE OF A READOUT MODULE PROTOTYPE VERSION 1. WORK STATEMENT: PROVIDE GAS ENCLOSURE FOR A READOUT MODULE V1 PROTOTYPE AND MATERIAL/EQUIPMENT TO PRODUCE THE ENCLOSURE.
1.2	1.2.1	1.2.1.4	1.2.1.4.1	**TPC v1 Module Common Mechanics**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE COMMON MECHANICS OF A READOUT MODULE PROTOTYPE VERSION 1, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE. WORK STATEMENT: PROVIDE COMMON MECHANICS FOR A READOUT MODULE V1 PROTOTYPE AND MATERIAL/EQUIPMENT TO PRODUCE THE COMMON MECHANICS.
1.2	1.2.1	1.2.1.4	1.2.1.4.2	**TPC v1a Module Prototype**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE READOUT MODULE PROTOTYPE VERSION 1A, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE. WORK STATEMENT: PROVIDE A READOUT MODULE V1A PROTOTYPE AND MATERIAL/EQUIPMENT TO PRODUCE THE READOUT MODULE.
1.2	1.2.1	1.2.1.4	1.2.1.4.4	**TPC v1b Module Prototype**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE READOUT MODULE PROTOTYPE VERSION 1B, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE. WORK STATEMENT: PROVIDE A READOUT MODULE V1B PROTOTYPE AND MATERIAL/EQUIPMENT TO PRODUCE THE READOUT MODULE.
1.2	1.2.1	1.2.1.5		**TPC v2 Modules**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE GEM READOUT MODULE PROTOTYPE VERSION 2, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE. WORK STATEMENT: PROVIDE GEM READOUT MODULE V2 PROTOTYPE AND MATERIAL/EQUIPMENT TO PRODUCE THE MODULES.
1.2	1.2.1	1.2.1.5	1.2.1.5.1	**TPC v2 Module Gas Enclosure**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE GAS ENCLOSURE OF A READOUT MODULE PROTOTYPE VERSION 2. WORK STATEMENT: PROVIDE GAS ENCLOSURE FOR A READOUT MODULE V2 PROTOTYPE AND MATERIAL/EQUIPMENT TO PRODUCE THE ENCLOSURE.
1.2	1.2.1	1.2.1.5	1.2.1.5.2	**TPC v2 Module Common Mechanics**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE COMMON MECHANICS OF A READOUT MODULE PROTOTYPE VERSION 2, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE. WORK STATEMENT: PROVIDE COMMON MECHANICS FOR A READOUT MODULE V2 PROTOTYPE AND MATERIAL/EQUIPMENT TO PRODUCE THE COMMON MECHANICS.
1.2	1.2.1	1.2.1.5	1.2.1.5.3	**TPC v2a Module Prototype**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE READOUT MODULE PROTOTYPE VERSION 2A, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE. WORK STATEMENT: PROVIDE A READOUT MODULE V2A PROTOTYPE AND MATERIAL/EQUIPMENT TO PRODUCE THE READOUT MODULE.
1.2	1.2.1	1.2.1.6		**TPC Production GEM Acquisition**	TECHNICAL SCOPE: THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO ACQUIRE COMPONENTS FOR THE GEM FOILS

WBS Dictionary – Examples

WBS Dictionary to Work Package Level (Deliverable)

1.2 1.2.1 1.2.1.1 **TPC v1 Field Cage Prototype**

<u>TECHNICAL SCOPE</u>: *THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE TPC FIELD CAGE PROTOTYPE VERSION 1, PERFORM R&D, DESIGN AND CONSTRUCT THE ELEMENTS OF THIS PROTOTYPE.WORK STATEMENT: PROVIDE PROTOTYPE: FIELD CAGE V1 PROTOTYPE.*

1.4 1.4.2 1.4.2.2 **Outer HCAL Sector Mechanical Structure**

<u>TECHNICAL SCOPE</u>: *THIS ITEM CONTAINS ALL TASKS WHICH ARE REQUIRED TO IDENTITY COMPONENTS FOR THE OUTER HCAL MECHANICAL STRUCTURE, DESIGN AND CONSTRUCT THE MECHANICAL ELEMENTS OF THE OUTER HADRONIC CALORIMETER. WORK STATEMENT: PROVIDE OUTER HADRONIC CALORIMETER MECHANICAL STRUCTURE.*

Basis of Estimate

	sPHENIX Detector **Relativistic Heavy Ion Collider** **BASIS of ESTIMATE (BoE)**	**Date of Est:** 3/1/2017 **Prepared By:** E.J. Mannel **DocNo. (refer Rev.** DocDB-65

Work Package Name: Sensor Procurement	**WBS Number:** 1.5.1	**Control Account Number**

WBS Dictionary Definition:

This work packages covers the procurement and Q/A testing of the preproduction and production optical sensors for the EMCal and HCal detectors.

Estimate Type (check all that apply):

____	**Work Complete**
____	**Existing Purchase Order**
____	**Catalog Listing or Industrial Construction Database**
X	**Documented Vendor Quotation based on Drawings/Sketches/Specifications**
X	**Budgetary Estimate by Vendor/Fabricator based on Sketches, Drawings, or other Written Correspondence**
x	**Engineering Estimate based on Similar Items or Procedures**
____	**Engineering Estimate based on Analysis**
X	**Expert Opinion**

Nav | Sensor_Procurement_Summary | 1.5.1Tasks | 1.5.1Costing | ModuleCounts

See next slide

Basis of Estimate

sPHENIX WBS 1.5.1: Optical Sensors
Date: 2/28/17
Last Revision Date: 25-Apr-2017

DESCRIPTION	MANUFACTURER	PART NO.	QUANT.	Cost Basis	Date	Unit Cost	Total Cost	Total Cost+10%	Contingency	Total Cost + Contingency
Optical Sensor:Preproduction	Hamamatsu	S12572-015P	1700	Quote	2/14/2017	15.00	25,500.00		0.00	25,500.00
Optical Sensor:Production	Hamamatsu	S12572-015P	112128	Budget Quote	3/20/2014	8.50	953,088.00	1,048,396.80	0.40	1,467,755.52
Test Stand	TBD		1	Engineering Est	3/1/2017	10,000.00	10,000.00	11,000.00	0.40	15,400.00

Preproduction Quote

HAMAMATSU
PHOTON IS OUR BUSINESS

360 Foothill Road
PO Box 6910
Bridgewater, NJ 08807-0910
Phone 908-231-0960
Fax 908-450-1140
Email **order@hamamatsu.com**

Account Name
Brookhaven National Laboratory
Attention
Sean Stoll stoll@bnl.gov (631) 344-5331
Address
apinvoices@bnl.gov Upton,NY 11973

Quote #	QUO-33798-W3Z5J8
Reference #	KXU17-3863495 , KXU17-6442992
Date	2/14/2017
Created By	

Ardavan Ghassemi
Phone
908-252-7632
Email
AGhassemi@hamamatsu.com

Please submit orders to ***order@hamamatsu.com.***

Valid Until	Sales Engineer	Terms	Ship Via
3/31/2017	Ghassemi, Ardavan	Net 30 Days	

Nav | Sensor_Procurement_Summary | 1.5.1Tasks | 1.5.1Costing | ModuleCounts

Ready

Risk Registry

sPHENIX Risk Registry

Owner	WBS	Risk Name	Risk trigger (if)	Consequences (then)	Timeframe	Probability	Impact	Rank	Mitigation Plan
E.O'Brien	1.1 Management	Departure of Key Personnel	Someone critical to the Project informs of his intention to leave sPHENIX	Schedule delay occurs	all	10%	Schedule: 3 months	Low	Closely work with sPHENIX collaboration to identify a potential replacement.
E.O'Brien	1.1 Management	Safety incident	Safety incident resulting in injury	Schedule delay occurs	all	5%	Schedule: 1 month	Low	Carefully plan all work in accordance with BNL SBMS. Include safety reviews and safety review recommendations implementation in sPHENIX resource loaded schedule.
E.O'Brien	1.1 Management	Funding profile stretches	Funds not available on time	Cost increases because procurements need to be broken down into smaller units, or existing quotes expire, or new contracts need to be negotiated.	production	50%	Schedule: 12-24 months Cost: $500K	High	Work closely with the funding agency so any funding profile changes can be evaluated as early as possible and sPHENIX Project schedule optimally adjusted to match the new funding profile.
E.O'Brien	1.1 Management	Infrastructure support delayed	Infrastructure milestone is delayed	Project activities dependent on Infrastructure milestone are delayed	all	5%	Schedule: 2 months	Low	Develop a detailed resource loaded schedule with key milestones for Infrastructure support and closely monitor this schedule for risk triggers.
T. Hemmick	1.2 TPC	Procure v1a GEMs	Delivery date on v1-shapes GEMs leaves less than one month before magnet test.	The test will require that we use existing GEMs which will be 10x10cm^2. This will require a special module to adapt the smaller square GEMs to the standard opening.	R&D Phase	20%	Cost $10k for square-GEM adapter parts	Low	In case the proper GEMs for the v1a prototype are not in hand, an adapter plate will be requires to fit an existing GEM-stack to allow the magnet test to proceed.
T. Hemmick	1.2 TPC	Performance failure of v2 prototype	The v2 prototype fails in any performance criterion that requires more thasn trivial re-design.	If the v2 prototype fails, then there will need to be a v3 prototype added to the cycle.	R&D phase	5%	Schedule: 2 months of float lost. Cost:$15k (only gain structure at risk…new GEMs)	Moderate	We will add a design cycle of a smaller device than the full sized field cage if the v1 prototype fails. We will proceed on v2 only after success of the small version.
T. Hemmick	1.2 TPC	Failure or delay of CERN production	Factories wait upon GEM foil delivery and suffer schedule shifts.	The factory production of modules is critical path and will directly affect schedule.	production	10%	Schedule: 3-5 months	Moderate	We will monitor carefully the success of CERN foil production and will hire a technician who will exclusively work on producing GEM foils for our project. If delays still occur, we will seek a second vendor.
T. Hemmick	1.2 TPC	SAMPA Chip Failure	SAMPA chips fail to match performance specifications.	Affects delivery of the TPC since FEE must be applied before delivery.	production	2%	Schedule: Unknown since mediation requires action from ALICE.	Moderate	ALICE and STAR shall be forced to mitigate the situation and if not, alternatives such as the sALTRO and DREAM chips must be considered.
S. Stoll	1.3 EmCal	Loss of W powder supplier	Failure of the primary supplier of W powder (Tungsten Heavy Powder) to sign a contract and deliver the powder for the final block production at an affordable price.	Would need to obtain a quote and sign a contract with a different supplier for the powder. This will cause a delay in the schedule and possibly an increase in cost. In addition, powder from a different vendor could lead to poorer detector performance.	production	Low 20%	High. Cost: price increase > $500k. Schedule: 9 mo to rebid/negotiate contract/ place order.	Moderate	Find another source of W powder which can meet our specs. Some have already been investigated. Attempt to identify primary source of raw powder in China and identify new distributor. Accept degraded detector performance if new powder does not meeet specs.
S. Stoll	1.3 EmCal	Loss of SciFi supplier	Failure of fiber vendor to sign a contract or deliver fiber on time.	Would cause a delay in the schedule and result in higher cost for the fiber	production	Moderate 30%	Moderate Cost: $1.4M higher cost for alternate supplier	Moderate	Two suppliers have been identified. We believe both can meet our specs, but one is roughly 2X high cost. If the lower priced supplier cannot deliver then we must use contingency to purchase from the other supplier.
S. Stoll	1.3 EmCal	Loss of primary production site for blocks (University of Illinois Urbana Champaign)	UIUC decides to not fabricate the absorber blocks	Would cause a delay in schedule and a significant increase in labor resources required to build the blocks at BNL.	production	Low 10%	High Cost: Slight cost increase to relocate factory to BNL Schedule: Significant. At least 12 mo. Delay to set up new factory and begin production	High	Blocks would have to be built at BNL. However, we would also loose scientific oversight provided by UIUC, student labor, free use of facilities, space, etc.
S. Stoll	1.3 EmCal	Cannot find a cost effective solution for making light guides	R&D studies and beam tests do not lead to improvements in the light collection uniformity from the modules	Will require position dependent correction for obtaining the desired energy resolution from the detector	R&D phase	High 75%	Low - Scope: Poorer detector energy resolution	Moderate	We will have optical quality injection molded light guides produced with what we believe will be the optimal shape given the space constraints of the detector. The resulting energy resolution will be measured in a beam test.
J. Lajoie	1.4 HCal	Loss of scintillating tile provider (Uniplast)	Uniplast is unable to engage in or complete the production contract	Schedule delay in the procurement of the scintillating tiles, along with correspond delays in inner and outer HCAL assembly.	production	10%	Schedule: 6-9 months	Moderate	Explore alternate scintillator vendors (FNAL, Elgin).
J. Lajoie	1.4 HCal	Unable to produce inner HCAL in SS310 in a cost effective manner	Evaluation of inner HCAL prototype yields higher than anticipated production costs	Schedule delay in finalizing the design of the inner HCAL; re-engineering required.	production	25%	Schedule: 6 months	Moderate	Investigate value-engineering designs and alternate materials (brass); will require re-engineering.
J. Lajoie	1.4 HCal	Unable to identify suitable site(s) for inner HCAL assembly (scint. and electronics)	No participating University site can identify the space resources for assembly.	Schedule delay to set up assembly site at BNL	production	5%	Schedule 3 months	Low	Investigate possibility of assembly (scintillator and electronics) at BNL.
E. Mannel	1.5 Cal Electronics	Delay in SiPM Delivery	SiPM order not placed on schedule or vendor unable to meet production schedule	Delay in assembly of HCal and EmCal SiPM daughter boards. Potential delay in HCal and EMCal module assembly	Procurement	Moderate: 50%	Low: Schedule delay 2-3 months	Low	Closely monitor the procurement stage.
E. Mannel	1.5 Cal Electronics	Delay in testing of SiPMs	SiPM Delivery not placed on schedule or vendor unable to meet prodcution schedule	Delay in assembly of HCal and EMCal SiPM daughter boards. Potential delay in HCal and EMCal module assembly	Production	Moderate: 50%	Low: Schedule delay 2-3 months	Low	Increase number of testing stations. Identify additional collaborators who can contribute to the testing program. Streamline testing program.
E. Mannel	1.5 Cal Electronics	Delay in Assembly of HCal Daughter boards, Preamps, Interface boards, LED Drivers	Procurement of components, issuing of orders.	Potential delay in HCal module assembly and testing	Production	Moderate: 25%	Low: Schedule delay 2-3 months	Low	Staged partial deliveries of boards. Use multiple assembly houses
E. Mannel	1.5 Cal Electronics	Delay in assembly of EMCal Daughter boards, Preamps or Interface boards	Procurement of components, issuing of orders.	Potential delay in EMCal module assembly and testing	Production	Moderate: 25%	Low: Schedule delay 2-3 months	Low	Staged partial deliveries of boards. Use multiple assembly houses
M. Purschke	1.6 DAQ/Trigger	DAQ Prototype	Tests with the various prototype stages reveal problems	DAQ prototype throughput and performance is below specifications	All	Moderate: 25%	Cost, increase number of boards/PCs	Low	Acquire more expensive PCs / re-design parts of the architecture
M. Purschke	1.6 DAQ/Trigger	Network switch	One of the currently identified vendors go out of business	Network switch more expensive than projected	Production	Low 20%	Cost due to lack of alternatives, Schedule (1Month)	Low	alternate vendors, different brands / getting acquainted with potentially new software interface
M. Purschke	1.6 DAQ/Trigger	Global Lvl1	Loss of engineering expertise due to employees leaving	adaptation of PHENIX GL1 runs into obstacles	Production	Low 20%	Schedule (2 months)	Low	select different card, identify a different engineer
M. Purschke	1.6 DAQ/Trigger	Timing System	insufficient number of now-obsolete parts	Conversion/adaptation from GLINK problematic, or envisioned replacement board cannot be used	All	Low 10%	Schedule 3 months	Low	select different card, re-engineer fiber interface
M. Purschke	1.6 DAQ/Trigger	Local LVL1	Simulations reveal the failure of an envisiond algorithm	Performance of LLVL1 algorithms inadequate. Trigger latency too high.	Production	Moderate 30%	Schedule 3 months	Moderate	Prioritize Physics goals, procure more hardware
M. Purschke	1.6 DAQ/Trigger	Storage	The TPC or other subsystem cannot meet the envisioned data reduction specifications	Data volume, especially from the TPC, too high	Production	Moderate 30%	cost ($100K)	Moderate	Invest in more local storage, change compression algorithms
M. Chiu	1.7 MinBias	Magnetic field capability of BBC PMTs	Testing shows PMT gain drops below spec for B-field at preferred MBD location.	Must move MBD further away in z, losing some MB efficiency	All	2%	Moderate: Cost: $0, Schedule: 0-6 months	Low	Testing mesh dynode PMTs to remove uncertainty in B-field performance. Worst case, move BBC to z=±300 cm
K. Yip	1.8 SuperConducting Magnet	Magnet does not work; cannot achieve specified field	Failure of magnet to reach field. Possible causes, Internal electrical failure, vacuum leak failure, cryo system failure, Power supply failure	Detector System can't resolve data without adequate magnetic field. Rework of magnet to correct deficiency is necessary	All	Low 10%	High: Cost ~$100-500K schedule 6-12 mos	Moderate	Full field test at bldg 912 prior to transport to bldg 1008 to proe out magnet performance, cryo, power supply and quench detection systems. Electrical check (warm) at 1008 to check for faults induced in shipping. Final full field/mapping test in 1008 IR.
P. Giannotti	1.9 Infrastructure	Engineering Resources not available	Engineering not available for timely design efforts	Cascading delays to production, assembly and installation	Design	Moderate: 30%	Moderate: Cost: $0, Schedule: 0-6 months	Moderate	Schedule relies on significant engineering resources not yet fully committed. Get early commitments from contributing groups for timely participation
P. Giannotti	1.9 Infrastructure	Cradle Fabrication delayed	Fabrication delayed	Cradle not available on time to commence assembly and installation	Installation	low: 10%	Moderate: Cost: $0, Schedule: 0-6 months	Low	Reliable experienced fabricator(s), adequate schedule contingency
D. Lynch	1.10 Integration and Installation	Subsystem not ready for installation	Subsystem not delivered in time for scheduled installation	Delays in construction/installation of sPHENIX	Installation	Moderate: 30%	Moderate: Cost: $0, Schedule: 0-6 months	Moderate	Build in adequate schedule contingency
D. Lynch	1.10 Integration and Installation	Labor not available for installation	Labor not available for timely installation	Delays in construction/installation of sPHENIX	Installation	low: 10%	Moderate: Cost: 0-$20K, Schedule: 0-6 months	Low	Secure more labor support/ temporary hires
D. Lynch	1.10 Integration and Installation	Pole Tips delayed	Fabrication delayed	Pole tips not available when scheduled for installation:delays move to IR for following installation.	Installation	low: 10%	Moderate: Cost: $0, Schedule: 0-6 months	Low	Reliable experienced fabricator(s), adequate schedule contingency (pole tips installation near end of installation schedule)

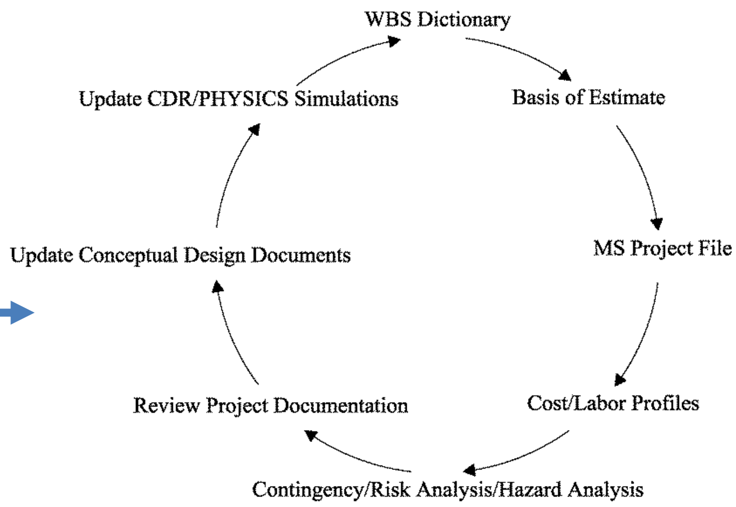
Risk Registry

	sPHENIX Risk Registry								
Owner	WBS	Risk Name	Risk trigger (if)	Consequences (then)	Timeframe	Probability	Impact	Rank	Mitigation Plan
E. Mannel	1.5 Cal Electronics	Delay in SiPM Delivery	SiPM order not placed on schedule or vendor unable to meet prodcution schedule	Delay in assembly of Hcal and EMCal SiPM daughter boards. Potential delay in Hcal and EMCal module assembly	Procurement	Moderate: 50%	Low: Schedule delay 2-3 months	Low	Closely monitor the procurement stage.
E. Mannel	1.5 Cal Electronics	Delay in testing of SiPMs	SiPM Delivery not placed on schedule or vendor unable to meet prodcution schedule	Delay in assembly of Hcal and EMCal SiPM daughter boards. Potential delay in Hcal and EMCal module assembly	Production	Moderate: 50%	Low: Schedule delay 2-3 months	Low	Increase number of testing stations. Identify additional collaborators who can contribute to the testing program. Streamline testing program.
E. Mannel	1.5 Cal Electronics	Delay in Assembly of HCal Daughter boards, Preamps, Interface boards, LED Drivers	Procurement of components, issuing of orders.	Potential delay in HCal module assembly and testing	Production	Moderate: 25%	Low: Schedule delay 2-3 months	Low	Staged partial deliveries of boards. Use multiple assembly houses
E. Mannel	1.5 Cal Electronics	Delay in assemblly of EMCal Daughter boards, Preamps or Interface boards	Procurement of components, issuing of orders.	Potential delay in EMCal module assembly and testing	Production	Moderate: 25%	Low: Schedule delay 2-3 months	Low	Staged partial deliveries of boards. Use multiple assembly houses

Summary

CD-1 sPHENIX Documents

1. Integrated Project Team
2. WBS (WBS Dictionary)
3. Basis of Estimate
4. Contingency Risk/Analysis
5. Activity List & Activity Attributes
6. Project Schedule
7. Critical Milestones
8. Proposed Funding Profile
9. Proposed Labor Profile
10. Preliminary Hazard Analysis Report
11. NEPA Document
12. Integrated Safety Management Plan
13. Conceptual Design/Conceptual Design Report
14. Acquisition Strategy
15. Close all previous review recommendations
16. Preliminary Project Execution Plan
17. Preliminary Risk Management Plan
18. Preliminary Risk Assessment and Risk Registry
19. Preliminary Security Vulnerability Assessment (Short security equipment protection & cyber security)
20. Alternate Analysis- For the PEP includes scientific alternatives



Over 20 Documents in Preparation for CD-1 Review
Continuous Improvement of Documentation, Estimates, Schedule, Scope
Level 2 Presentation: Scope, WBS Dictionary, Basis of Estimate, Schedule, Risk